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Age Determination from Radiological Study of Epiphysial Appearance and Fusion Around Elbow Joint in Relation to Birth Certificates In 16-20 Year Age Group

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Abstract *— Objective: To determine the frequency of extent of fusion of epiphysis in the bones of elbow joint (lower ends of humerus and upper ends of radius and ulna). Study Design: Descriptive observational study. Place and Duration of Study: This study was conducted at the Forensic Medicine and Radiology Departments, Govt. Hospital, J.L.N Medical College from January 2023 to September 2024. Materials and Methods: 50 patients between aged 13-21 years were selected for this study. X-rays of elbow joint were taken in antero-posterior view to visualize the changes in epiphysis and diaphysis and extent of union. Subjects with fractured, malnourished and congenitally malformed elbow joint were excluded from the study after expert opinion from orthopaedic surgeon. Results: The complete fusion of epiphyses of the bones around elbow joints was observed at age of 19-21 years (Stage 4) in males and at age of 16-18 years (Stage 4) in females. Present study found that union of epiphyses of distal humerus and proximal radius and ulna appear in females earlier than in males. Conclusion: 100% complete union of elbow joint bones, in male cases is at 19-21 year, and 100% complete union of bones of elbow joint in female cases is at the age of 16-18 years.*

Keywords *— Age assessment, Epiphyseal fusion, Elbow joints*

I. INTRODUCTION

Determination of the age of an individual from the appearance and the fusion of the ossification centres is a well accepted fact in the field of medical and legal professions. Epiphysis of bones unites during age periods which are remarkably constant for a particular epiphysis[1]. The determination of age presents a task of considerable importance from the view-point of the administration of justice. It is not possible to enunciate a hard and fast rule for age determination from this union for the whole India because India is composed of areas which differ in climatic, dietetic and disease factors which affect skeletal growth[2]. Determination of the age of an individual from the appearance and the fusion of the ossification centers is a well accepted fact in the field of medical and legal professions. The present study was carried out to study roentgeno graphically the epiphysial appearance and union at elbow joint in

subjects between age group of 16-20 years attending outpatient department of this hospital.

Age estimation is a common feature and problem of Forensic practice all over the world. In a country like ours it is more so, since illiteracy is a common feature and awareness for birth registration is too less. Scientific determination of age of an individual is a necessity for the law enforcement agencies in both civil and criminal matters. Various processes and methods of age estimation have been evolved through decades. As a matter of fact, ageing of the human being starts right from the moment of conception. During the span of life, various features of development and growth occur in chronological order.

As a matter of fact, no age is exempted from a medicolegal point of view. From the moment of conception to the death of an individual, almost every age has some medicolegal importance. Particularly, the age of the individual is of paramount importance in employment and retirement both in private and government sectors. So the assessment of age with a degree of objectivity and certainty is important in medico legal circumstances. For all long bones the fusion of epiphysis takes place at 20 years of age except clavicle[3] and presence and eruption of all the four wisdom teeth almost confirm that an individual is not less than 25 years. The epiphyseal union at shoulder is studied in various part of the world. Several studies indicate that epiphyseal end of humerus unites at about the age of 17-18years[4] . This study aims to find out the age of appearance & fusion of ossification centres of the shoulder joint using digital X-rays in relation to their per birth-certificates.An attempt has been made to study the authenticity of age estimation from ossification center.

AIM AND OBJECTIVES

AIM

To study the age determination by radiological examination of fusion of epiphyseal centres of elbow joint in relation to birth certificates in subjects between 16-20 years of age.

OBJECTIVES

1. To assess the age determination from fusion of epiphyseal centres of elbow joint in subjects between 16-20 years of age using digital X-rays in Ajmer region.
2. To assess and compare radiological age to the documented age as per the birth certificate.
3. Suggestions for authenticity of age estimation from ossification centres, physical and dental examination.

II. MATERIAL & METHOD

This study will be carried out at the Department of Forensic Medicine, JLN Medical college, Ajmer with assistance from Department of Radiology, for radiological examination after obtaining due clearance from research and review board of JLN Medical College and Hospital, Ajmer.

Study design: Community based Descriptive Observational Study.

Study period: 1st April, 2023 to 31st March, 2024 or Until the Sample Size is achieved; whichever is earlier.

Study universe: Students and staff of Medical, nursing & other paramedical college as well as students from academic institutions of Ajmer between the age group of 16-20 years with reliable document of date of birth.

Inclusion criteria:

- Should belong to Rajasthan by origin or staying for last 10 years in the Ajmer region.
- Only Subjects who have documentary evidence of age in the form of birth certificate issued by Nagar Nigam & competent authority and matriculation certificate.
- Age group: 16-20 years.
- Subjects who give their consent for participation in the study.

Exclusion criteria:

- Subjects without proof of birth record.

- Subjects below 16 years and above 20 years.
- Subjects with Severe malnutrition.
- Subjects with Chronic illness.
- Subjects with Endocrinal disorders.
- Subjects with deformities of limbs and pelvis.

Method of collection of data:

After obtaining consent from the subjects satisfying the inclusion criteria and obtaining valid informed written consent, the general physical examination will be conducted to know the health status and rule out any deformities to select the subjects after applying exclusion criteria.

Materials:

- Printer black ink
- Data collecting instrument, X-ray film
- Lead marker, lead apron
- 8 x 10 inches rigid cassette
- Film hanger (8" x 10")
- Developer Solution
- View box
- Magnifying lens
- Weighing machine and height measuring scale
- Proforma
- **Sampling method**:
- Stratified Random Sampling based on age.
- Sample size – 87(39 Boys + 48 girls)

Computing sample size for Females

- Previous studies tell us that 80 % cases of epiphysial union occurs in specified 16-18 year period.

Precision=we'd like the result to be within 10% of true value.

Confidence level: convention=95%=1-α

α = 0.05 ; Z(1- α /2) one tailed test=1.65 in practice of forensic medicine research is going on over fusion of epiphysis so upper end is taken for consideration

Corresponding to significance level of 0.05

p= 0.80 whereas q =1-p=0.20; Plugging all values in formula

$n=z^2pq/ d^2 = (1.65)^2(.80)(.20)/(0.1)^2 =43.56 =44$ sample

10% extra sample for Geographical variation (previous studies not being conducted in Ajmer) =48 sample

Computing sample size for Males

- Previous studies tell us that 85 % cases of epiphysial union occurs in specified 18-20 year period.

Precision=we'd like the result to be within 10% of true value.

Confidence level: convention=95%=1-α

α = 0.05 ; Z(1- α /2) one tailed test=1.65 in practice of forensic medicine research is going on over fusion of epiphysis so upper end is taken for consideration

Corresponding to significance level of 0.05

p= 0.85 whereas q =1-p=0.15

Plugging all values in formula

$n=z^2pq/ d^2$

$=(1.65)^2(.85)(.15)/(0.1)^2 =34.71 =35$ sample

10% extra sample for Geographical variation (previous studies not being conducted in Ajmer) =39 sample

III. METHOD

After selection of cases, the personal details will be recorded and after taking informed written consent clinical and dental examination will be carried out and details recorded in pre-proposed Performa. The subjects will then be subjected to Digital X-ray examination of shoulder joint. The Radiographs will then be studied for appearance and fusion of ossification centres and age determination will be done on basis of the table of Galustan in Modi's textbook of Medical Jurisprudence. The

documented age of the subject will also be noted and the determined age will be analysed in relation to the documented age (as per birth certificates).

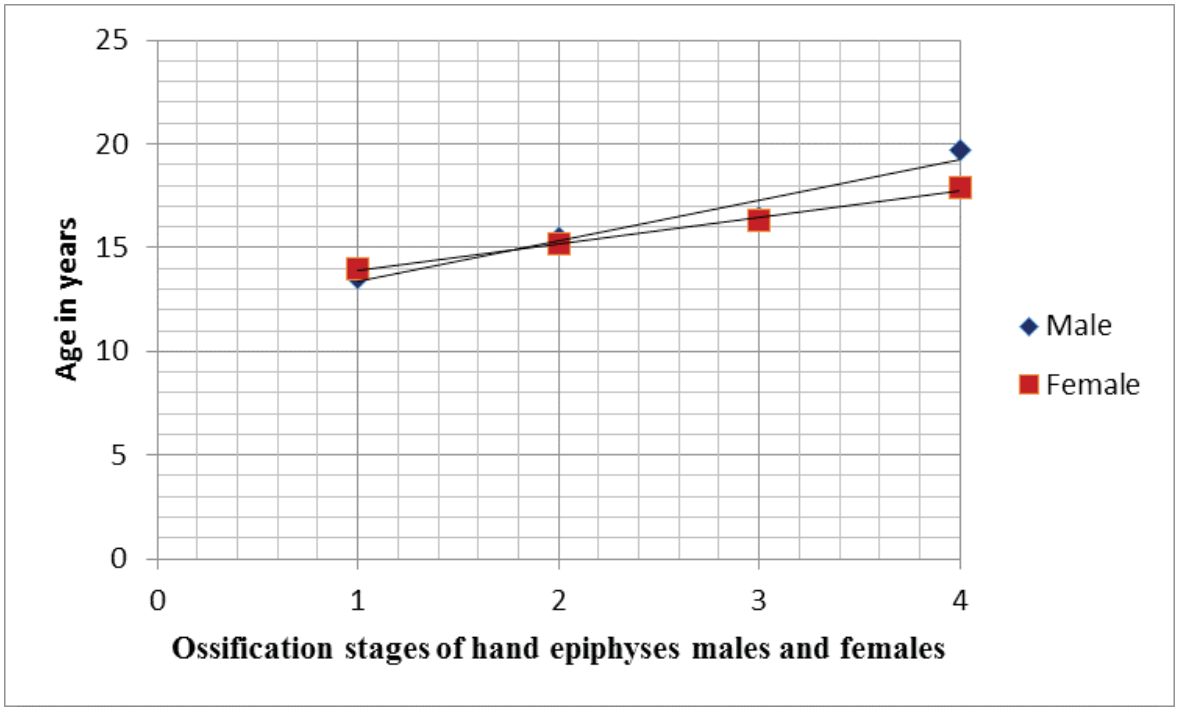
Statistical analysis

The finally analysed data would then be tabulated in Microsoft Excel Worksheet and statistically analysed using appropriate statistical software to determine its significance at 95% confidence limits. The collected qualitative data will be expressed in groups, diagrams, proportion and percentages and analysed using appropriate statistical tests. The quantitative data will be expressed in linear and standard deviation and analysed by appropriate statistical tests as per the data obtained. Continuous data would be expressed in form of proportion and percentages differences in proportion would be analysed using chi square test. P<0.05 will be considered significant.

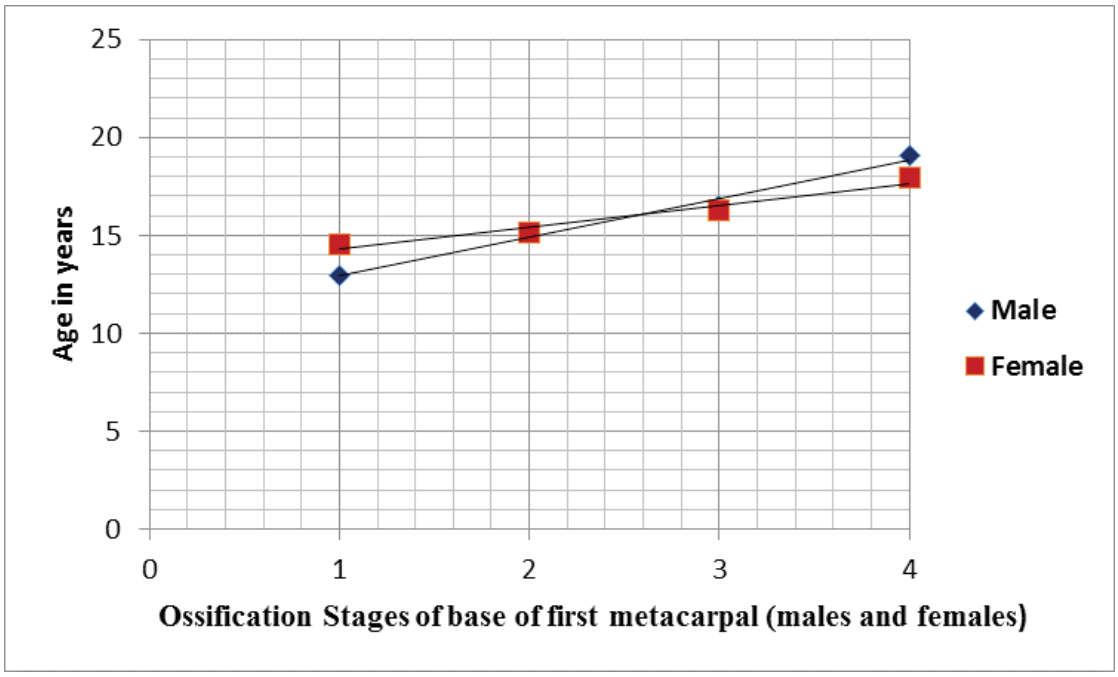
IV. RESULT

Table1: Showing the number of cases and stages of ossification based on radiographic evaluation at Various centers

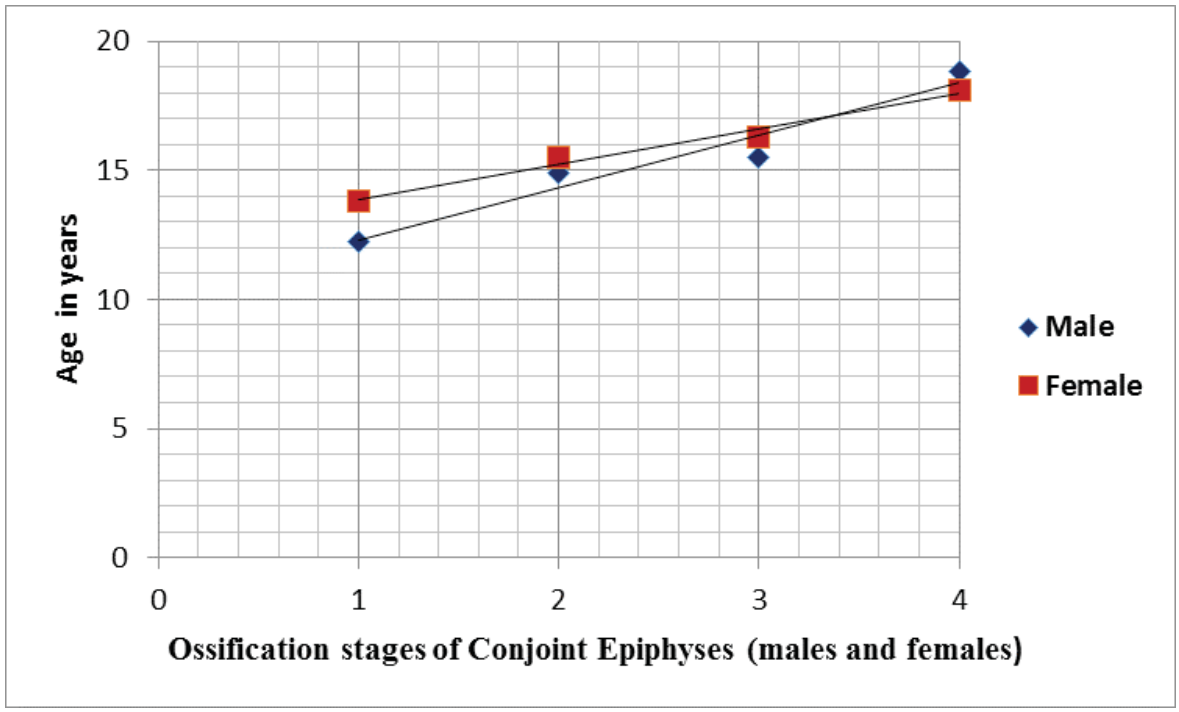
No of Patients (N)	Stages of Ossification					No of Patients (N)	Stages of Ossification				
	0	1	2	3	4		0	1	2	3	4
	Staging of Handepiphyses (Male)						Staging of Handepiphyses (Female)				
26	0	9	1	4	12	46	0	8	22	9	7
	Staging of Base of first Metacarpal (Male)						Staging of Base of first Metacarpal (Female)				
26	0	7	3	2	14	46	0	4	24	4	14
	Staging of Conjoint Epiphyses (Male)						Staging of Conjoint Epiphyses (Female)				
26	0	2	6	2	16	46	0	3	4	4	35



Graph1: Showing the mean age at different ossification stages of hand epiphyses (males and females)



Graph2: Showing the mean age at different ossification stages of base of first metacarpal (males and Females)



Graph3: Showing the mean age at different ossification stages of Conjoint Epiphyses (males and females)

V. DISCUSSION

The present study was done in n=26 male and n=46 females the male to female ratio was 1:1.76. This study consisted of a predominantly urban population of Ajmer District in rajasthan State with different ethnicity, race, socioeconomic status and residency, and these factors do impact the epiphyseal union. In a country as diverse as India, it is difficult to follow a simple standard for determination of age across the entire country. We in the present study estimated the ossifications at 3 centers and mean values were considered this willnegate the small variations between the different stages at different centers. Previous studies have shown that union age for each epiphyseal plate at the knee joint and hand joint has similar union stages.[2, 6]A study by Majed O. Aljuaid et al; [7] showed a stronger correlation of the hand joint bones both males and females as compared to knee joint for estimation of age accurately. In the present study, we found in males the average age at stage I (beginning of union) was 12.90 years and stage IV (complete union) was 19.18 years. For females Stage,I (beginning of union) was 14.12 and stage IV (completeunion) was17.96 years.It shows that the average age of fusion is higher in males as compared to females. The female subjects commence

fusion at the age of 13 - 14 years of age and complete it by 17-18 years while the male subjects commence fusion at 14-15 years and completeit at 19-20 years. A study by S Kishna moorthy et al;[8]found that complete fusion of distal end of the ulna was foundin18-19years in males and 17 – 18 years in females. In the current study, we found the distal end of ulna fused with shaft completely at 19.7 years in males and 17.86 years in females agreeing with the results of the above study. Other studies in India by Hepworthin Punjab[9],Kothari in Marwar[10],and Suniletal;[11]all have found similar results across India. S. Shanmugasundaram et al; [12] found the base of the metacarpal fusion was completed from 15 to 19 years. The average age range of fusionof 4th and 5th metacarpals ranges from 15 – 17 years in girls in boys' fusion occurs between 17 to 18 years. In our study, we found the base of the first metacarpal in boys ossified completely by 19 years, and in females, it occurred at 17.94 years. In our study, we found in boys the Conjoint Epiphyses was in stage 3 unions at 15.5 years and stage IV was at 18.8 years and in females, Conjoint Epiphyses was in stage 3 unions in 16.3 and stage IV in 18.1 years. Similar observations have been found by Lal et al;[13]and JainS[14].Although we found that in several studies they have used different criteria for evaluation of ossifications hence there may be some variations between the results of the present study compared to the other studies.

VI. CONCLUSION

Within the constraints of the present study, we found that hand wrist and elbow joint radiographs are very useful for estimation of bone age in cases upto 18 years of age. We used digital radiographs along stages for determining the degree of ossification which has a greater degree of reproducibility and reliability. Although several studies have been conducted for age estimation using radiographs there was no uniform method of assessment of age. We hope that in future a standardized method could be adopted for wider application across the country.

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